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**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Application No.: 09/994,560  
Confirmation No.: 8731  
First-Named Inventor: Harold L. Bennett  
Filing Date: November 27, 2001  
Group Art Unit: 1714  
Examiner: Cephia D. Toomer  
Attorney Docket No.: 031088-000002  
Title: PROCESS FOR PRODUCTION OF LOW-TEMPERATURE CHAR  
DURING PRODUCTION OF LOW-TEMPERATURE TARs

**RENEWED PETITION UNDER 37 C.F.R. § 1.137(B)**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

In response to the Decision mailed April 8, 2009, Applicant hereby renews the petition to revive the application, pursuant to 37 C.F.R. § 1.182, and, in the alternative, pursuant to 37 C.F.R. §§ 1.137 and 1.181. In support of the renewed petition, please consider the following remarks and evidence.

**Petition Under 37 C.F.R. § 1.182**

According to the Decision on Petition, mailed May 8, 2009, the petition pursuant to 37 C.F.R. § 1.182 was dismissed on the grounds that this section of the Regulations provides for questions not specifically provided for elsewhere in the regulations. According to the Decision, the relief sought is provided for under 37 C.F.R. § 1.181, and "the question of whether the application should be revived is provided for in the regulations at 37 C.F.R. § 1.137."

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Applicant respectfully submits that it is seeking relief that is not described under the provisions of § 1.137 (though Applicant also seeks relief, in the alternative, under those provisions.) Section 1.137 only provides for the revival of an application that becomes abandoned *due to an applicant's failure to timely reply* to an office action. As the record in this file plainly shows, the amendment was timely filed, and, therefore, the application did not become abandoned due to the applicant's failure to file a timely response.

As discussed in the petition, Applicant (by counsel) filed a timely response to the office action. This response canceled claims to the subject matter that the Examiner had rejected, and amended the claims to correct the technical objections made by the Examiner to the claims the Examiner had indicated were patentable. In other words, the response sought to implement all of the changes that the Examiner had indicated would place the application in a condition for allowance, and only those changes.

This response was misplaced by Patent Office. When Examiner Toomer contacted Applicant's counsel, asking whether a response had been filed, counsel informed her that one had. Counsel for Applicant also informed Examiner Toomer that, should she be unable to locate the response, Applicant would be happy to provide a replacement copy. The Examiner never requested such a replacement, leading Applicant's counsel to conclude that the response had been located.

Applicant therefore respectfully notes that it seeks revival of the application on grounds not specifically provided for under the standards set forth in 37 C.F.R. § 1.137, nor anywhere else in the rules: Applicant seeks entry of an amendment that placed the application in a condition for allowance, and which was timely filed but which, due to an error in the Patent Office, the Patent Office failed to enter. Applicant also seeks such further action as is

appropriate in view of the entry of the amendment, including an opportunity to pay the associated issue fees or correct any minor informality that the Examiner may find in the response.

**Petition Under 37 C.F.R. § 1.181 and § 1.137**

In the alternative, Applicant respectfully seeks further consideration of its petition to revive pursuant to 37 C.F.R. § 1.137, and, in view of the positions set forth in the Decision, pursuant to 37 C.F.R. § 1.181.

According to the Decision, the fact that a response was timely filed “supports a conclusion that the delay was unintentional,” but that there is a “real question as to whether there was ever a deliberate decision not to continue prosecution.” The Decision therefore concludes that “it is appropriate to request additional explanation as to why the delay in filing a response of the Office action and in filing a petition should be considered unintentional (or unavoidable).”

As to the request for an explanation as to the delay in filing a response to the Office action, again, there simply was no such delay—the response was timely filed. In view of the comments of Examiner Toomer, it appears that the Patent Office misplaced the response, and, despite saying that, if unable to locate it, she would ask for another copy, she failed to do so.

As to the request for an explanation as to the delay in filing a petition to revive, in response to this request, Applicant has reviewed his records and located a business plan dated August, 2005 (attached hereto as Exhibit A). This business plan includes a capitalization plan that was prepared in April, 2003. It also includes an explicit reference to the instant patent application, including a copy of the text of the Abstract (located on the last page). It is respectfully submitted that this document shows that, as of both April, 2003 and August, 2005,

Applicant still believed the application to be pending, and that the applicant's failure to seek revival of the application was the consequence of the fact that he believed the application was still pending, awaiting further action by the Patent Office. The application is listed as having been abandoned effective April 16, 2003.

In further support, counsel for Applicant's counsel notes that, from our records, it does not appear that a Notice of Abandonment was ever received. Had one been received, there would have been a corresponding docket entry, given the state of the file at that time, to file a petition to revive. Our records reflect no such docket entry. It is also our procedure to mount any such notice of abandonment in the file, and no such notice is in our file.

**Further Comments:**

Applicant notes that revival of the application is consistent with the public interest. Disclosure of the invention to the public has not been delayed, since the application was published on May 29, 2003. Furthermore, Applicant could not gain, and the delay in prosecution was not an attempt to gain, any unfair patent term extension. The term of any patent that might issue would be 20 years from the date of filing. Any term adjustment that might otherwise be provided pursuant to 35 U.S.C. § 1.54(b) based upon events prior to this petition is likely limited by 35 U.S.C. § 1.54(b)(2)(C)(i), but, in any event, should the application be revived and an extension of time be added to the term for such pre-petition delays, Applicant will terminally disclaim such term.

## Conclusion

It is respectfully submitted that, by the amendment that was timely filed on May 15, 2003, the application was placed in a condition for allowance. Applicant requests that the amendment be entered, and that further appropriate action in view of that amendment be taken.

Respectfully submitted,

By /Quentin G. Cantrell/

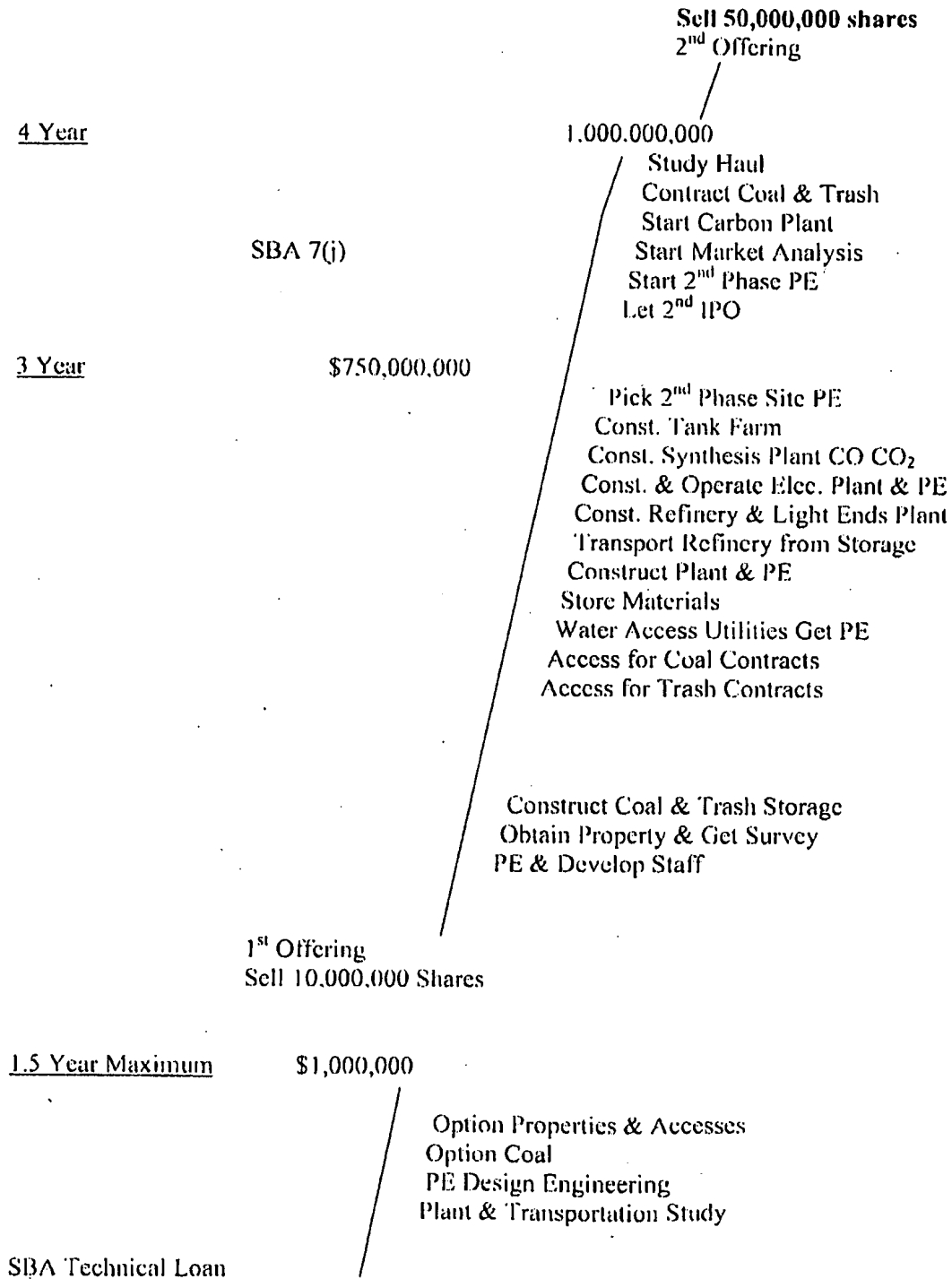
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**PROPOSED BUSINESS PLAN  
COLUMBIA FUEL COMPANY, INC.  
(Bennett Process)**

**April 2005**

## PROPOSED BUDGET AND SCHEDULE

August 2003



# **COLUMBIA FUEL COMPANY, INC.**

**April 2005**

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The enclosed material contains a description of the Bennett patents and privy and/or confidential information contained in other Bennett patent applications. All information gleamed from this paper shall be held in confidence.

## CONCLUSIONS:

1. The conditions that have made low temperature coal carbonization uneconomical in the past have now been reversed. The market for aromatics from coal tars now exists in the form of petrochemicals and motor fuel finishers. The use of char in a powdered form for electrical production has evolved; therefore, it is no longer necessary to produce a nut or lump char.
2. The chars will be soft and easy to crush, reactive and readily ignited, burn readily without special attention, and clean burning. It is reported that it may be stored safely and indefinitely in powdered form and it is anticipated that a considerably smaller furnace can be used for boilers than for coal.
3. The coal can be cleaned of pyrites and stored in accordance with normal mining or utility operations. A substantial amount of sulfur in the form of pyrites will be removed.
4. The coal will be roasted in the presence of steam, thus enhancing the quantity and quality of the primary tars and gases.
5. The primary tar will be hydrogenated in the presence of a cobalt-molybdenum catalyst producing synthetic crude oil.
6. The synthetic crude oil will be refined into gasoline, finishers, and/or petrochemicals.
7. The chars will be treated with  $H_2$  and a substantial amount of the remaining sulfur will be removed.
8. The need for a new industry to treat bituminous coals to produce semi coke (char) and liquid fuels can be economically justified.
9. The basic technology for low temperature carbonization of bituminous coals was established prior to 1946.

The Bennett Process adds the following new or revised dimensions to the technology:

- A. The primary tars can be successfully hydrogenated using the Law technique.
- B. The char can be rendered into a low sulfur fuel using FMC and Conoco techniques
- C. The heat transfer during carbonizing of the char will be facilitated with constant agitation.
- D. The quality and quantity of the primary tars will be increased by inserting steam into the roaster to facilitate gas removal with little decomposition.
- E. Carbon monoxides and carbon dioxides will be synthesized into products.
- F. Little if any development of new equipment is required. All processes can be conducted within existing technology.
- G. The process is not dependent upon closely held foreign gas technology for adequate product production.
- H. Low temperature and low pressure processing allows for construction with low cost domestic iron and steel alloys.
- I. Critical operations can be carried out in a carbon dioxide or oxygen free atmosphere. If workmen are necessary a life support system will be used.

## EXECUTIVE SUMMARY

### NON-POLLUTING FUEL FROM BITUMINOUS COAL

By Harold L. Bennett

Our nation is faced with a precarious situation in regard to its energy needs. For energy supplies we are too heavily dependent upon nations that, at the whim of an unfriendly leader, could dry up our sources of vital commodities. The present turmoil in the Far East is a timely warning. Should similar unrest spread to its neighboring countries, the bulk of the world's present oil supplies could cease to flow.

In a few years our own reserves of oil may be depleted, thus making us totally dependent upon imports. At that point we would not only cease to be a world power, but we would be faced with the struggle for survival. Such thoughts are awesome contemplate, but they could become reality. We must take emergency measures to halt that rapid trend toward disaster.

The answer lies in converting bituminous coal into non-polluting smokeless fuels, synthetic crude oils, and aromatic gases, etc, using the BENNETT PROCESS.

It is estimated that the United States has sufficient coal reserves to last for several hundred years. This abundant resource is not being fully utilized because present coal firing technology has a poisonous effect on the atmosphere, or pollution. These problems can be resolved with adequate funding

Attempts have been made to use high-pressure equipment and experiments to do so are still underway. These methods will require five to ten years of experimentation—time

which we cannot afford to waste. It is urgent that we develop a source of non-polluting smokeless fuel and liquid fuel now.

The technology for an alternate process is now in existence; known as the Bennett Process. it will be outlined in detail. The completed design is available and can be implemented upon approval of financing.

The Bennett Process will produce a smokeless solid fuel for U. S./Mexico installations and for current coal fired utilities. This fuel will eliminate the need for high cost smoke stack scrubbers, precipitators and/or sulfur acceptors and their inherent disposal problems.

Capturing the smoke and nitrous oxides and other pollutants prior to electrical generation, etc., will reduce some of the objections to increasing the use of coal over the next 30-40 years. Smoke is the material that is to be converted to liquid fuel, etc., by the Bennett Process.

Electric utility companies do not wish to run gasification and liquification plants. The U.S. public has indicated a distrust of allowing the coal/oil companies to have that responsibility. Therefore, the proposed creation of a new industrial component to provide solid fuel to the electric companies, etc., and synthetic crude for feed stock to the gasoline and petrochemical industry appears to be timely.

The proposed methods will require an increased production of coal in the magnitude of 20 to 30 percent, depending upon the volatile content of the coal used. Additional transportation should not be a problem as the initial facilities can be located so as to take advantage of existing rail, pipelines, barging, coal supplies and utility sites.

## DEVELOPING THE PROCESS

We would propose that stock in the existing corporation, i.e., Columbia Fuel Co., Inc., be opened and revised to have at least 10,000,000 Common shares and the authority to issue 10,000,000 Preferred shares. The company would seek financing to construct a facility as described above in Western New Mexico. Preliminary inquiries have been made with Giant Oil Company.

Due to the complexity of the total project, we would propose to issue 10,000,000 LLC common shares to the Columbia group, and for example 900,000 Preferred shares plus 100,000 Common shares to the Underwriters. An IPO would be made as soon as we can get the char operations started.

Additional funding will be requested to develop the petrochemical and lightends plants, etc.

## MARKET PRODUCTS TO BE DERIVED

The initial installation will produce the following critical material (from bituminous coals, lignites, soft trash and sewage):

1. Clean burning smokeless boiler fuel for electricity and heat production in western U.S. and eastern U.S. defense facilities, production of steel, filters and activated carbon products..

The initial market will be in New Mexico, Arizona, Colorado, Utah and the western United States. The market area will be further expanded throughout the United States and Mexico as new products are developed.

Additional products can be developed with additional refinery and petrochemical equipment.

1. Benzenes, xylenols, toluene, butane and propane for finishing non-lead gasoline and necessary additives for plastic production. Also basic ingredients for other fuels and explosives will be produced.
2. Lead free gasoline for domestic vehicles.
3. LPG for bottled heat and power at isolated facilities and production of synthetics fuels.
4. Low sulfur coke for steel production, activated carbon filters, hydrogen, etc.
5. Sulfur for chemical production.
6. Hydrogen gas for auto fuel, etc.

## **ADDITIONAL DATA**

It has been decided that we will use up to 20% by weight of solid waste material during carbonization of the coal. This material will be hydrocarbon trash, solid sewage, peat and farm waste. We will contract with various cities for these materials, which will be transported by train, barge, etc. to the plant site. The cities will pay for the transportation of these materials.

The feedstock (coal) can also be peat or lignite from Texas or Mexico.

The company could use an existing NM corporation, CJL, which is a subchapter "S" corporation. This would allow the principal stockholders to take personal advantage of any federal tax discounts.



## BENNETT PROCESS

### Introduction

As an alternative to petroleum derived fuel, we propose to utilize available and existing technology to produce synthetic crude oil and smokeless solid fuel (char) from bituminous coals. The synthetic crude oil derived from low temperature coal tars can be processed by any of several systems well known in the petroleum refining industry. The initial step in processing tar is to treat it with hydrogen, thereby converting it to synthetic crude oil. A naphtha boiling below 250° C rich in aromatics and phenols will be distilled.

The char residue produced at low temperature may be utilized as fuel in producing electric power or may be further reduced to coke. The char will retain enough volatile matter to be considered medium or high volatile fuel. It will make good smokeless fuel for domestic and industrial usages.

The clean Bennett produced char will lend itself to fluidized bed combustion methods. With its clean-burning, smokeless, low CO<sub>x</sub> and NO<sub>x</sub> emissions, the fuel should prove to be an enhancement to the utility industry.

To facilitate the analysis of the Bennett Process, this paper has been modeled from papers produced by TVA of various processes used in flue gas desulfurization and a paper by P. S. Farber et al of Argonne National Laboratory.

## HISTORY

Late in the 1940's the research work on low temperature carbonization sponsored by the Bureau of Mines, Department of the Interior, was sharply curtailed and the research emphasis shifted to coal liquefaction and/or gasification. The markets for smokeless solid fuel and synthetic crude had not developed and it was apparent that they would not develop in the near future. The war was over and adequate petroleum reserves were available. The home heating, industrial and railroad uses of coal were on the decline with the advent of interstate transportation of natural gas. Adequate metallurgical coking coals were available and hydrotreating of crude oil was supplying the budding petrochemical industry with adequate feedstock.

There were adequate liquid and gas reserves for the foreseeable future. Therefore, many regulated industries were permitted to convert from coal to oil or gas. The bituminous coal industry was depressed and the anthracite coal companies were abolished. This was done on the assumption that the problems of developing coal liquefaction and/or gasification would be adequately solved prior to depletion of the petroleum reserves. This has proven to be a false assumption (Oil and Gas Journal).

Other factors not foreseen in the late 1940's were:

1. The surging development of the petrochemical industry.
2. The Environmental Protective Act.
3. The Mine Safety Act.
4. The emergence of the third world countries and their inflationary pricing of their petroleum exports.
5. Lack of an agricultural export pricing policy.

All of these have tended to increase our dependence on the petroleum industry and increase our demand for liquid products.

The Bennett Process, like the modern Portland cement concrete and Roman concrete or modern steel alloys and Damascus steel, is a wedding of the best of the old German and the current U.S. technology to the space age equipment, materials, and marketing practices.

Rhodes defined the German synthetic program as the methods and technology to produce the maximum amount of liquid petroleum products and metallurgical coke for steel or char for electricity production.

The Bennett Process will treat bituminous coals in a low temperature manner to produce a soft, easily ignitable char particle (-3/8"); synthetic crude oil high in aromatic and/or aliphatic

compounds; gases for plant heat,  $H_2$ , and product production, and/or synthesizing; and various inorganic compounds containing sulfur and/or ammonia.

The process is dividable into five distinct areas:

1. Coal processing and clean up.
2. Carbonization.
3. Synthetic crude production.
4. Gas processing.
5. Char clean up.

## **COAL PROCESSING AND CLEAN UP**

Depending upon the origin of the coal, the pyrites and shale or slate should be removed prior to roasting the coal. This may involve crushing and hydraulic separation by one of several methods known to the industry.

Even though the pyrites are exothermic when roasted, the additional sulfur in the roaster gases may tend to be undesirable and the heat of the char particle will not be controllable.

The cleaned coal, to satisfy the material on hand requirements of various electric companies, will need to be stored for several weeks. To prevent drying and loss of volatile material and subsequent reduction in tar production, the coal shall be stored in a wet or damp condition and surface dried just prior to roasting thus preventing weathering and oxidation.

The coal shall be transferred from the storage-drying area via a continuous belt to a hopper arrangement at the top of the roaster. The feed shall be adjustable and coordinated with the speed of the roaster arms so as to provide adequate carbonizing temperature and retention time in the roaster.

## COAL FIRING

**Char** – a product of low-temperature carbonization and thermal decomposition of bituminous coal.

Char is referred to as semi-coke (producer fuel) or smokeless fuel containing from 10 to 15 percent of volatile matter. It is highly porous and friable. It is non-caking and water free. The decomposition of coal results in a 70% reduction in volume. A use must be found for the 70% of the coal residue (char).

The firing of producer char in a solid fuel boiler would have many advantages as follows:

1. It would be delivered in powdered form. No grinding costs.
2. It would burn without soot or smoke. No emitter screening.
3. It would be water free. Reducing plant maintenance and burning costs.
4. A minimal amount of volatile matter will be present in the flue gas. Some hydrogen will be present and will react with the carbon to form CO-CO<sub>2</sub>.
5. The dew point of the water pressure will be below 101°F. The dew point of natural gas is reported to be 139°F.
6. All FOB for coal can be absorbed by the carbonizing plant.
7. By installing a CO-CO<sub>2</sub> synthesizer with a condenser in front, all carry-over particles will be returned to the bed.

The utilization of this char material in electric producing boiler plants will, therefore, result in a substantial savings (up to 30% estimated).

### PRIMARY GAS FROM COKE PRODUCTION

Depending upon product specifications and the coal used, it may be desirable to further process the sulfur reduced char into a low volatile coke. The additional heat to produce the coke could be in the form of super heated steam, hot gases, or indirect heat. Regardless of the type of heating used, a gas rich in methane and free  $H_2$  will be released. This gas, if evolved, will be used for heat,  $H_2$  and the CO synthesis process to produce oil and alcohol.

✓ Preliminary analysis of the process indicated that for most high volatile, non-coking coals there will be substantial gas evolved containing  $H_2$  for the necessary reaction and enough hydrocarbons to balance the processes heat requirements.

As described above the heat balance demands can be adjusted with the production of water gas and/or coke. Excess gases can be utilized to produce synthetic oil and alcohol and/or gases can be developed into products in a light ends plant.

## Refinery

The section from the gas clean up and tar removal forward shall be considered the refinery portion and costs will be estimated on the basis of refinery methods set out in the Oil and Gas Journal. The estimate will be based on Costimating and Nelson Inflation Indexes as is common in the industry.

### Basis of Estimate:

The plant shall have a battery limit of 15,000 barrels per day (B/D) and an estimated thru put of 14,000 B/D of synthetic crude oil.

The roaster shall derive 10,730 B/D of low temperature tar which shall be hydrogenated with an expansion factor of 120 to 140%.

The reactor is a high-pressure catalytic cracker with a fixed bed catalyst. A modified standard catalytic cracker will be satisfactory. Hydrogen uptake shall be 1200 to 1500 scf per barrel (bbl). The output shall be distilled in an ordinary petroleum topping tower. The distillate shall be naphtha boiling below 250° C, rich in aromatics and phenols. All bottoms shall be recycled and receive additional hydrogen treatment.

For simplicity of preparing this estimate, the naphtha shall be considered at the current U.S. price.

The refinery envisioned is estimated to have a complexity factor of 6.5 which is about normal for a plant of this small size.

Gas evolved by the reactor and the topping tower distillation will be transferred to a gas plant.

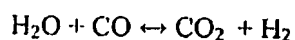
### Process Description Used for This Estimate

The power plant is an integrated facility that includes the equipment necessary to clean the coal, convert the coal to char, convert the char to heat and electricity, remove the gases containing coal tars from the char, produce synthetic crude oil, and produce sulfuric acid and fertilizer.

The coal is to be delivered to the yard where it is crushed and mechanically cleaned. The crushed clean coal is transported by belts, etc. to the top of a multi-hearth roaster. The volatile matter is removed by indirect heating. Gases containing tars are removed from each level as quickly as possible to prevent further decomposition.

The gases are cooled and the tar condensed. The condensed tar is treated with hydrogen in the presence of a catalyst and under pressure (hydrofining). The synthetic crude oil so derived is fractionally distilled and the naphtha derived. Additional products such as gasoline and petrochemicals can be derived from the naphtha; however, it is not necessary to discuss additional processing in the economic analysis.

The hot char is transferred to the bottom area of the roaster via rotating arms at each level. There it will be treated with  $H_2$  gas or with a gas containing  $H_2$  developed by using steam to cool the char.



The char will contain substantially reduced amounts of sulfur if present and will be sized less than 3/8 inches. This material will be cooled as necessary and stored for fuel to make electricity, etc..

For the purpose of this analysis, the major by-products of the fuel-processing system are sulfuric acid, ammonia, synthetic crude oil (naphtha), and petrochemical feedstock, LPG and electric plant heat.



TABLE I

## Size of Tar Reactor and Distillation Unit

Tar	23.8 gal/Ton or coal*	
Coal carbonized		10,500 T/D
Tar	23.8 gal/T X 10,500 T/D/44gal/B	5,680 B/D
Tar to H <sub>2</sub> reactor = synthetic crude		
SC = 120 to 140 % of tar		
5,680 B/D X 1.3 fac		7,383 B/D
Tar at 1.40 expansion		10,340 B/D
Therefore, assume battery limits of		10,000 B/D

TABLE II

## A Typical New Mexico Coal Used to Analyze the Bennett Process

## Assumed Coal Source\*

State	New Mexico
County	San Juan
Bed	No. 4
Sulfur	2.2%
Volatile Matter	43.8%
BTU Value Coal	13,630. BTU/lb.

Carbonizing Temperature 500° C

## Output

Tar Yield	23.8 gal/Ton coal
Char Yield	64.5% of coal
Char BTU Value	14,270 BTU/lb.
Gas Yield	2,000 cf/Ton coal.
Gas BTU Value	830 BTU/lb. Coal

\*Values derived from U.S. Dept of Interior Technical Paper #525, "Carbonizing Properties and Constitution of....Indiana No. 4 Bed Coal from Saxton No. 1 Mine Vigo Co. Ind..." and modified for New Mexico coals

TABLE III

## Gas Clean Up

## From TVA Report

Reduce sulfur from 5% to 3.5% by mechanical clean up if necessary.

## From FMC Report Using a Colorado Coal

Reduced by .4% sulfur from coal by roasting and clean from tar

## From FMC Report

Reduce 60% of sulfur from char by flash addition of  $H_2$  in first 2 minutes. (shallow bed)

The results should be within the 85% removal requirement set out in the proposed EPA Standards.

## BASIS

2600 ft. of gas evolved during roasting

.06% by volume of synthetic crude evolved as gas in distillation per Fischer

$H_2$ ,  $H_2SO_4$ ,  $N_2$ ,  $CO_2$  removed from gas

Remove 33.7% for impurities

2600 cfs - 876 cfs = 1724 cfs methane gas/ton coal

@ assumed minimum of 1000 BTU/cfs =

1,724,000 BTU/T coal =

34,480 MM BTU/D

## From Tar Reactor

.06 X 99% = .59% as light oil

20,000 T/D X 23.8 gal/T X .06 = 28,560 gal.

28,560 = 37,428 gal.

SG .771

Light oil equivalent = 102 BTU/lb. of coal

102 BTU X 20,000 X 2,000 =

4,080 MM BTU/D

## From Coal Distillation

Light oil equivalent 140 BTU/lb. coal

140 BTU/lb. X 20,000 T/D X 2,000 lb. T =

5,600 MM BTU/D

TOTAL BTU AVAILABLE =

44,160 MM BTU/D

Char clean up costs were prorated from the FMC report and Oil & Gas Journal for April 2, 2001. Claus clean up process was directly prorated for the acid unit from the TVA report Table B21 (noting that the table was based on 1.5 MM Ton/yr of coal). The costs were only doubled because our producer gas is higher quality.

Gas clean up costs were developed from values for H<sub>2</sub> adsorption, nitrogen recovery and H<sub>2</sub> reform from the amount of CO gas developed in the system according to Oil & Gas Journal.

Refinery costs were developed from Oil & Gas Journal Costimating Series and Nelson Cost Index Inflation Factors. The current literature on the subject verifies the accuracy of the method. It was assumed that a fixed bed hydrofiner with a high efficiency distillation tower was used to convert the tar to synthetic crude oil.

Materials—coal cost was established in P. S. Farber (of Argonne) Paper 3A page 27 as \$1. per M BTU's and expanded to \$1.7 per M BTU's. For continuity of comparison, we have used the latter value.

Conversion costs were taken and were prorated from the costs shown in Table B1 PCC Process 1 by TVA. (Clean coal storage was moved to the section on char cleaning.)

The roaster costs were prorated by FMC titled Char Oil Energy Development. The costs shown as 1967 were expanded by Nelson Cost Index Inflation Factors from 1.83 to 173.2 for 2005

TABLE IV  
Heat Requirements

Coal heating to 600° C

$$10,500 \text{ T/D} \times 2000 \text{ lb./T} \times 2812.5 \text{ BTU/lb. coal} = 59,060 \text{ MM BTU/D}$$

Amount of O<sub>2</sub> in coal Assume 22.5%

From Fischer use 176 cal./lb. char

Char uses 12,703 MM BTU/D

Assume 40% eff. = 31,750 MM BTU/D

Well within allowable 44,160 MM BTU/D from Table III

Leaving 5860 MM BTU for refinery heat

TABLE V  
H<sub>2</sub> Recovery Balance

Assume no H<sub>2</sub> recovery from reactor or distillation as it is a continuous operation and H<sub>2</sub> remains in system.

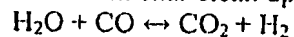
H<sub>2</sub> available = 23.4% of gas X 2600 scf/T coal

$$680 \text{ scf} \times 20,000 \text{ T/D} = 13,600,000 \text{ scf/D}$$

H<sub>2</sub> required for tar clean up

$$23.8 \text{ gal. Of tar/T coal} \times 10,500 \text{ T/D} \times \text{B/42 gal} \times 1200 \text{ scf/B} = 7.14 \text{ MM scf/Day}$$

H<sub>2</sub> available from char clean up by



H<sub>2</sub> needed for H<sub>2</sub>S is 0.05% of off gas from char clean up

with 95% H<sub>2</sub> processed.

$$.7 \text{ lb. H}_2/\text{hr/lb. char (per FMC)}$$

H<sub>2</sub> needed for IIS removal = 575/1440 MM scf H<sub>2</sub> = .8 MM scf/day

.8 MM scf H<sub>2</sub> produced by steam injection (reform) and incomplete oxidation of char.

TABLE VI

## Hydrogen Sulfide and Nitrogen Oxide Removal Costs

NO<sub>x</sub> Removal

1.2% of 2600 scf = 31.2 scf/T coal

31.2 scf/T X 10,000 = 312,000 scf

Plant cost \$.20/M scf =

\$2 Million

H<sub>2</sub>S Removal from Synthetic Crude Production

Remove .5% of 2600 scf/T = 13 scf/T

13 scf/T X 10,000 T/D = 130,000 scf/D

1.5% X 10,000 T/D = 300,000 lb/D

From Oil & Gas Journal 9-11-78

Assume 505 L/D recovery with char clean up \$2 MM

TABLE VII

## Basis of Design

Using New Mexico San Juan County coal and processing it nearby beginning in mid 2006, average basis of cost scaling, ending 2006; operation time 7,920 hr/yr (330 days), a 36% increase over TVA.

15 day raw coal and 15 day clean coal storage capacities.

Working capital provides 3 weeks raw coal consumption, 7 weeks direct revenue costs (excluding BTU loss) and 7-weeks operating overhead.

Refuse disposal located within 1 mile from plant sites.

Raw coal (moisture free) 3,300,000 ton/yr, 5% S, 7.0% Ash, 11470 BTU/lb

Clean coal 3,050,000 Ton/yr, 3.67% S, 8.0% Ash, 1200 BTU/lb.

Char to boiler from roaster 2,800,000 T/yr with 13070 BTU/lb and 11.6% ash for boiler, 200 MW coal-fired power plant operating at 9500 BTU/kwh and 5500 hr/yr.

The methods and procedures for processes shown are for estimating purposes only. The final types of equipment and methods will be determined during design and will depend upon market conditions, site selection, and the coal or coals to be used. The most conservative costing was used. For example, there is no reason to believe that it will be necessary to use a claus sulfur dioxide process when the major portion of the sulfur will be in the form of hydrogen sulfide; however, if it is determined to process any pyrite and develop an acid product, the process may be necessary.

Environmental considerations will be minimized. By siting near an electrical utility, the waste steam and heat can be purchased and utilized in the process. The clean fuel will result in a substantial reduction in stack emissions. The process itself will only generate emissions from the development of the necessary heat for the coal roaster and steam production.

TABLE VIII

Product Value

	<u>MM \$/YR</u>
Synthetic crude oil values	
10,000 B/D @ 330 d/y = 3,300,000 B/y	
@ \$1.31/gal. = \$55.00/B =	\$ 550.00
Char value	
@ \$41.09/Ton X 2.45 MMT/yr =	\$ 91.40
Sulfuric acid	
@ \$58.65/LT X 175 LT/D X 330 D/yr =	\$ 3.30
Ammonia	
@ \$100/LT X 33 LT/D X 330 D/yr =	\$ 1.10
Light ends	
5% of crude oil = 165,000 B/yr	
\$165,000 B X 44/gal/B X \$1.60/gal. =	\$ 11.61
Sub total	\$ 657.41
Solid waste	
20% X 10,500 T/D X 330 D/Yr X \$65/T FOB plant	- \$ 38.31
Total Income	\$ 319.10

TABLE IX

## Total Capital Investment

<u>Direct Investment</u>	<u>Investment MM\$</u>
A. Coal receiving, storage and clean up	
a. Receiving, storage (10,500 T/D)	\$ 6.03
b. Raw coal sizing	\$ 1.10
c. Coarse coal cleaning	\$ 1.08
d. Intermediate coal cleaning	\$ 1.53
e. Fine coal cleaning	\$ 1.88
f. Solid waste storage	<u>\$ 2.08</u>
	\$ 13.70
B. Roaster (Pyrolysis 10,500 T/D)	\$ 12.02
Gas handling, removal, recovery, and clean up	\$ 7.05
Tar removal & recovery includes dust precipitation	<u>\$ 2.90</u>
	\$ 22.05
C. Char clean up 6825 T/D	
a. Desulfurization including	
Contactor	
Separator	
Char cooler	
b. Regenerator including	
Acceptor cooler	
Contactor	
Acceptor heat and calciner	
c. Recovery including (400 LT/D Claus unit)	
Burner	
Wash Heat Boiler	
Converters	
Condensers	
CO <sub>2</sub> Stripper and scrubber	\$ 26.45
Acid Production	\$ 6.82
Acid Storage	\$ 1.16
Clean Char Storage	<u>\$ 4.14</u>
	\$ 38.57
D. Gas clean up	
Hydrogen recovery	\$ 1.50
Nitrogen recovery	\$ 0.70
H <sub>2</sub> production (steam reform or other)	<u>\$ 9.88</u>
	\$ 12.08
E. Refinery	
Refinery 12,500 B/D @ \$4776/bbl day	\$ 59.70
(complexity 6.5)	
F. Steam plant including water storage pipes (and wells if necessary)	<u>\$ 4.133</u>
Total Direct Investment	\$135.88

TABLE IX (CON'D)

		<u>INVESTMENT MM\$</u>
<u>Indirect Investment</u>		
Engineering design and supervision		\$ 14.44
Architect and engineering contractor		\$ 2.11
Construction Expense		<u>\$ 19.91</u>
	Total indirect investment	\$ 36.46
Contingency		<u>\$ 4.00</u>
	Total fixed investment	\$ 40.46
<u>Other Capital Charges</u>		
Allowance for startup and modifications		\$ 28.74
Interest during construction		<u>\$ 35.50</u>
	Total depreciable investment	\$ 104.70
Land 40 ac. @ 2,000/ac.		\$ .08
Working capital		
3 weeks raw materials		\$ 18.99
7 weeks direct construction		<u>\$ 5.16</u>
	Total capital investment	\$128.93
Electric plant co-generation		
RR extension and siding		
Plastic plant co-utilization with light ends plant		
Roads		
Warehouse and offices		<u>\$ 71.07</u>
		\$200.00



TABLE X

## Annual Revenue Requirements

<u>Direct Costs</u>		<u>Investment/Yr in MM\$</u>	
A. Coal cleaning, storage and receiving			
Material—Coal @ \$1.5/M BTU* =		\$ 70.50	
Conversion costs			
Operating, labor & supervision		\$ 2.709	
Utilities			
Water		\$ 0.008	
Electricity		\$ 0.803	
Diesel fuel		\$ 0.139	
Materials		\$ 0.554	
Maintenance 6% of direct investment		<u>\$ 1.641</u>	
		\$ 96.34	
B. Roaster			
Diesel fuel		\$ 0.514	
Utilities (including water)		\$ 4.600	
Labor & Supervision		\$ 4.600	
Materials		<u>\$ 4.968</u>	
		\$ 14.682	
C. Sulfur removal and acid plant		N/A	
D. Gas clean up			Utilities
	\$ 1.093		
Cooling water		\$ 0.189	
Feedwater		\$ 0.069	
Labor & supervision		\$ 0.262	
Material		<u>\$ 0.154</u>	
		\$ 1.767	
E. Refinery costs			
	<u>¢/bbl</u>		
Labor & supervision	31.0		
Energy	37.2		
Maintenance & materials	5.2		
Chemicals	12.8		
Supplies	1.4		
Water	<u>1.4</u>		
Sub total	89.0		
Octane charge	<u>28.2</u>		
Process unit costs	117.2	\$ 20.00	

(Using FMC 1974 refinery estimate expanded to 2005 = \$25,830,000)

\*Includes credit for solid waste disposal.

(Continued on Next Page)

TABLE X (CON'D)

	<u>Investment/Yr in MM\$</u>
F. Steam plant	\$ 0.10
Material	
Water	
Labor & supervision	
Utilities	
Heat is derived from coal and credit for heat is included in product value	
	<hr/>
Total Direct Costs	\$ 132.89
<u>Indirect Costs</u>	
Capital charges	
Depreciation, interim replacements, and insurance at 6% of total depreciable investment	\$ 19.83
Average cost of capital and taxes @ 8.6% of total Capital investment	\$ 7.98
Overheads	
Plant, 50% of operating labor & supervision	\$ 4.928
Administrative, 10% of operating labor and supervision	\$ 0.985
Marketing, 10% of sales revenue	<u>\$ 8.370</u>
TOTAL ANNUAL COSTS	\$179.07
Credit from product sales	\$183.70

**BELOW IS AN EXCERPT AND ABSTRACT OF THE IMPROVED PATENT REVEALED  
AND FILED IN JUNE 2001**

**IMPROVED PROCESS FOR PRODUCTION OF LOW TEMPERATURE CHAR DURING  
PRODUCTION OF LOW TEMPERATURE TARS PER PAT. #3,576,734**

**Harold L. Bennett, Albuquerque, NM, Assignor to Bennett Engineers and Associates, Austin,  
Colorado 81410**

**ABSTRACT OF DISCLOSURE**

An improved process for the production of smokeless (low CO<sub>2</sub>-CO emitting) boiler fuels which have been obtained by careful temperature control and the addition of waste, trash or other carbon material during carbonization of various coal materials such as tar sands, bituminous coal, peat and lignite, and oil shale.